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Carbon dioxide fixation within mine wastes of ultramafic-hosted ore deposits: Examples from the Clinton Creek and Cassiar Chrysotile Deposits, Canada

Publications

Carbon dioxide (CO2) is sequestered through the weathering and subsequent mineralization of the chrysotile mine tailings at Clinton Creek, Yukon Territory, and Cassiar, British Columbia, Canada. Accelerated weathering is attributed to a dramatic increase in surface area,which occurs during the milling of ore. We provide a detailed account of the natural process of carbon trapping and storage as it occurs at Clinton Creek and Cassiar, including mineralogy, modes of occurrence, methods of formation for carbonate alteration, light stable isotope geochemistry, andradiocarbon analysis. Powder X-ray diffraction data were used to identify weathering products as the hydrated magnesium carbonate minerals nesquehonite [MgCO3·3H2O], ypingite [Mg5(CO3)4(OH)2·5H2O], hydromagnesite [Mg5(CO3)4(OH)2·4H2O], and less commonly lansfordite [MgCO3·5H2O]. Texturalrelationships suggest that carbonate precipitates formed in situ after milling and deposition of tailings. Samples of efflorescent nesquehonite are characterized by ä13C values between 6.52 per mil and 14.36 per mil, ä18O values between 20.93 per mil and 26.62 per mil, and F14C values (fraction ofmodern carbon) between 1.072 and 1.114, values which are consistent with temperature-dependent fractionation of modern atmospheric CO2 during mineralization. Samples of dypingite ± hydromagnesite collected from within 0.2 m of the tailings surface give ä13C values between -1.51 per mil and 10.02 permil, ä18O values between 17.53 per mil and 28.40 per mil, and F14C values between 1.026 and 1.146, which suggests precipitation from modern atmospheric CO2 in a soil-like environment. Field observations and isotopic data suggest that hydrated magnesium carbonate minerals formed in two environments.Nesquehonite formed in an evaporative environment on the surface of tailings piles, and dypingite and hydromagnesite formed in the subsurface environment with characteristics similar to soil carbonate. In both cases, these minerals have been trapping and storing the greenhouse gas, CO2, directlyfrom the atmosphere. Combined use of ä13C, ä18O, and F14C data has been applied effectively as a tool for verifying and monitoring sequestration of atmospheric CO2 within mine tailings. A number of other deposit types produce tailings suitable for CO2 sequestration, including Cu-Ni-PGE deposits,diamondiferous kimberlite pipes, and podiform

chromite deposits. Our results suggest that conversion of about 10 weight percent of tailings to carbonate minerals could offset the greenhouse gas emissions from many ultramafic-hosted mining operations. less

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Coverage

Map Area

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Classification

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